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Identifying Museum Insect Pest Damage

Museum collections are very susceptible to pest damage. The cumulative affects of this damage can ultimately destroy a museum object. Therefore, it is important to constantly monitor collections for evidence of pest activity.

Museum pests are biological agents that can cause damage to museum collections. Pests are organisms that interfere with the management objective of the site. Pests come in a variety of forms: insects, rodents, bats, birds and mold. For insects, often the first evidence of their presence is the resultant damage, cast skins, or fecal spots rather than the pest itself.

Insect pests that cause the most damage to museum collections can be arranged into the following groups based on the types of food sources they seek:

- Textile or Fabrics Pests
- Wood Pests
- Stored Product Pests
- Paper Pests
- General Pests

The nests of mice, rats, birds and bats also affect museum collections because they can attract insects that may then move into collections seeking a food source.

Evidence of Pest Activity

Evidence of insect activity includes:

- the presence of the actual insect, alive or dead, at various stages of its development
- cast skins or other body parts
- chewing marks
- exit holes in surfaces of wood
- hair, fur or feather loss
- webbing
- "grazed" surfaces
- frass (debris or excrement produced by insects, usually a soft powdery material)
- fecal pellets, dried stains or fecal spots

It is usually these signs, rather than the actual pest, that are detected first. Be familiar with the signs and inspect for pest evidence to detect activity and locate the source of the infestation.

Textile Pests

Also known as protein feeders, textile or fabric pests are among the very few animals that can digest keratin, the primary protein found in animal hair and horn (Fig. 1) or chitin which forms insect bodies (Fig. 2). Fabric pests are divided into three distinct groups: carpet beetles, hide beetles, and clothes moths.

Both carpet and hide beetles belong to the family Dermestidae. Dermestids are primarily scavengers that feed on a large variety of plant and animal-by-products, including leather, fur, feathers, skin, mounted museum specimens, woolen and silk textiles, floor coverings, stored foods and carrion.



Figure 1. Dermestid larvae damage to horn. (Barbara Cumberland, NPS)



Figure 2. Insect collection damaged by carpet beetles (Barbara Cumberland, NPS)

Carpet Beetles

The four most commonly encountered species of carpet beetles are the black carpet beetle, varied carpet beetle, furniture carpet beetle, and common carpet beetle. The larval stage of all carpet beetles is responsible for the damage. A carpet beetle infestation results in feeding damage (Fig. 3) and cast larval skins.



Figure 3. Grazing damage and frass from varied carpet beetle larvae. (Barbara Cumberland, NPS)

Hide and Larder Beetles

The three hide beetles that cause the most damage are the larder beetle, hide or leather beetle, and black larder beetle. They feed on skins and feathers such as dead bird or mouse carcasses in attics, stuffed animals in museum collections and in birds' nests. Both the adult and larval stage damages materials. Look for feeding damage and frass created (Fig. 4) as they often burrow into or graze the surface of their food source.



Figure 4. Leather cartridge box with tunneling by hide beetle. (Barbara Cumberland, NPS)

Clothes Moths

The term "clothes moth" can refer to three species of moths, the webbing clothes moth, case making clothes moth and carpet or tapestry moth. In museums, they often damage woolen clothes (Fig. 5), feather hats, dolls and toys, bristle brushes, weavings, and fabric wall hangings.

While many other moths are attracted to lights, these moths prefer dark closets, attics or other areas. The larvae tend to live and feed in dark corners in the folds of fabrics. Typically, the larva bites off a fiber, chews on it and moves on to the next fiber, resulting in a trail of damaged fibers. The clothes moth larvae may spin a feeding tube made of the fabric they are feeding on. Some spin small scattered silken patches and graze as they go along using the tube as protection. Look for feeding damage such as holes in woolen fabrics and hair falling from hides or pelts (Fig. 6). The color of the excreta usually takes on the color of the material on which it is feeding. Use these clues to locate infested collections.



Figure 5. Civil War hat with damage from clothes moths and carpet beetles. (Barbara Cumberland, NPS)



Figure 6. Webbing clothes moth damage. (Patrick Kelley, Insects Limited, Inc.)

Wood Pests

Museum objects made of wood are susceptible to attack by a number of wood-infesting pests. In museums, the culprits are usually wood-boring/powderpost beetles and drywood termites. Both can severely damage valuable artifacts while remaining invisible to the untrained eye.



Figure 7. Canteen damaged by powderpost beetles. (Barbara Cumberland, NPS)

Wood-boring/Powderpost Beetles

The term powderpost beetle applies to any of three closely related families: Lyctidae (true powderpost beetles that cannot digest cellulose

and attack the sapwood of hardwood only), Bostrichtidae (false powderpost beetles that attack both soft and hardwood), and Anobiidae (anobiid, furniture, and deathwatch beetles that attack both soft and hardwood, and prefer to feed on sapwood). The term "powderpost" comes from the very fine, powder-like frass (excrement and bits of wood) produced by the feeding process. Powderpost beetles infest wooden materials such as frames, books, toys, furniture, tool handles, gunstocks, lumber, paneling, and crating (Fig. 7), as well as girders, studs, flooring, and other wooden building components. Look for exit holes where a powder (beetle frass) will be found. Lyctid beetle frass is loose and has a very fine powder consistency. Bostrichid beetle frass has a tendency to stick together in clumps, feeling gritty to the touch. Anobiid beetle frass contains several pellets and sticks together in clumps.

Powderpost beetles spend most of their lives unseen as larvae tunneling within wood, so their frass and the exit holes they make in the wood's surface as they emerge as adult beetles are the primary signs of their presence. The adult beetles are short-lived and seldom seen. Reducing moisture is key in managing powderpost beetles.

Table 1. Characteristic Damage of Wood Pests

Beetle	Exit Holes	Frass
Anobiid	Circular. 1/16 to 1/8 in (1.6 to 3 mm) diameter	Fine powder with elongated pellets conspicuous; sticks together in clumps
Bostrichtid	Circular. 3/32 to 9/32 in (2.5 to 7 mm) diameter	Fine to coarse powder; feels gritty; tends to stick together
Lyctid	Circular. 1/32 to 1/16 in (0.8 to 1.6 mm) diam.	Fine, flour-like, loose in tunnels

Drywood Termites

Unlike their cousins the subterranean termites that require a constant moisture source, drywood termites establish colonies in dry, sound wood with low levels of moisture and do not require contact with the soil. Drywood termites attack wooden items of all kinds. Most infestations are in building structures but furniture and wooden objects in museum collections may also be attacked. The excavated galleries or tunnels feel sandpaper-smooth. Dry and loose, their distinct six-sided fecal pellets are found in piles where they have been kicked out of the chambers. Other than the pellets, there is very little external evidence of drywood termite attack in wood as they tend to work just under the surface of the wood (Fig. 8). Swarming adults may also be a sign of an infestation. Winged termites have four wings of equal length whereas carpenter ants have four wings of two different lengths.



Figure 8. Drywood termite damage to a wooden door. (Rudolf H. Scheffrahn, University of Florida, www.insectimages.org)

Stored Product Pests

Many museum collection storage spaces and exhibits may include objects made of nuts, seeds, grains, dried fruits and vegetables, spices, other foods and herbarium collections. Traditionally called "stored product pests", there are many insects that can infest these items. The most common pests in museums are two similar beetles, the cigarette beetle and the drug-

store beetle. Look for emergence holes and fine dust around target items to detect cigarette or drugstore beetle activity. Drugstore beetles can be detected by their feeding damage and sometimes leave shot holes (Fig. 9). The adults of both may be seen flying.

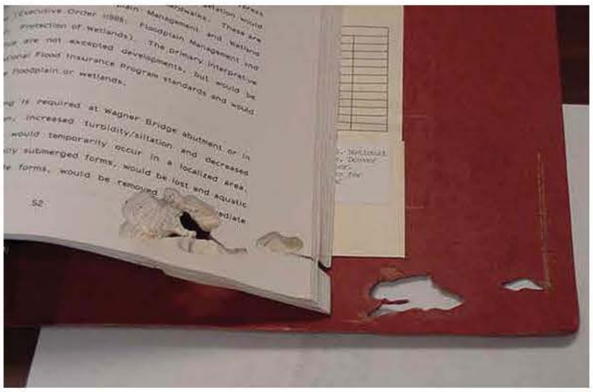


Figure 9. Possible termite or drugstore beetle damage to book. (Barbara Cumberland, NPS)

Paper Pests

Silverfish and Firebrats

Silverfish and firebrats prefer starchy foods and will eat fabrics, paper and sizing, and the glue and paste in older book bindings. They are omnivorous and will eat protein materials as well as cellulose (Fig. 10). Silverfish prefer moist situations with temperatures of 70° to 80°F and can be an indicator of moisture problems. Firebrats prefer temperatures in excess of 90°F. Signs of an infestation are seeing the insect or finding their feeding damage.



Figure 10. Silverfish damage. (Clemson Univ./USDA CES, www.insectimages.org)

Booklice

The presence of psocids, such as booklice, indicates a moisture problem. They primarily feed on microscopic molds and are usually found when a book is opened or paper is moved. They have been found on herbarium plant specimens that were not completely dried.

General Pests

Any household pest may become a pest in a museum. Crickets, centipedes, and cockroaches can invade and infest a museum, historic house or other structure. They can cause direct damage to collections through their feeding behaviors or provide a source of food for other pests. Both field and house crickets have been documented damaging fabrics and archival papers.

Crickets

Crickets have strong chewing mouthparts, are omnivorous and will eat protein and cellulose materials, including textiles (wool, silk, linen, and cotton), leather, and animal skins and fur.

Cockroaches

Cockroaches are omnivorous and feed on leather, paper, glues, animal skins, hair and wool fabrics, especially if the item is stained with food and sweat (Fig. 11). German cockroaches are found indoors in warm, humid areas, preferring crevices near food and water in bathrooms and kitchens. The brownbanded cockroach is also found indoors and requires less moisture. The German and brownbanded cockroaches are the only known domestic cockroach species that depend on human activities for survival.

The oriental cockroach prefers decaying food, is cold tolerant and prefers damp areas with temperatures below 84°F. It is often found in bark mulch around the perimeter of buildings. The American cockroach requires a water source and prefers fermented foods. It can be found in sewers and basements, particularly around drains and pipes. Cockroach fecal pellets can resemble small mouse droppings without pointed ends.



Figure 11. Cockroach damage to a book. (Patrick Kelley, Insects Limited, Inc.)

Identification of the insect pest and its life stage is critical to determine what threats to the resource are present. Once the pest is identified, determine the source and extent of the infestation and take the necessary steps to stop the infestation. Isolate the problem area or object and eliminate the conditions that may support re-infestation. It is essential to do regular and ongoing monitoring to detect pests and focus management activities. Encourage park personnel to report any signs of infestation immediately to museum staff.

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